

Claims:

1 1. A noise checking method used upon circuit
2 designing for checking noise which has an influence
3 on a signal waveform which propagates in a noticed
4 wiring line on a design object circuit,
5 characterized in that it comprises the steps of:
6 producing a simulation model of a circuit
7 portion relating to the noticed wiring line;
8 performing a simulation using the simulation
9 model to calculate a signal waveform which
10 propagates in the noticed wiring line and calculate
11 a noise waveform superposed on the signal waveform
12 in the noticed wiring line for each kind of noise;
13 synthesizing the signal waveform and the noise
14 waveforms calculated for the individual kinds of
15 noise with generation timings of the noise
16 waveforms taken into consideration to obtain a
17 noise composite waveform which is the signal
18 waveform on which the noise is superposed; and
19 performing noise checking based on the noise
20 composite waveform.

1 2. The noise checking method as set forth in
2 claim 1, characterized in that, where an adjacent
3 wiring line to the noticed wiring line is turned
4 back in such a manner as to have a plurality of

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5 proximate portions which can electrically
6 interfere with the noticed wiring line, simulation
7 models are produced with regard to the individual
8 proximate portions of the adjacent wiring line and
9 the noticed wiring line and the noise waveforms are
10 calculated using the simulation models, and then
11 the noise waveforms calculated with regard to all
12 of the proximate portions and the signal waveform
13 are synthesized with generation timings of the
14 noise waveforms taken into consideration.

1 3. The noise checking method as set forth in
2 claim 1, characterized in that, when the noise
3 checking is performed, a maximum delay time and a
4 minimum delay time of the noticed wiring line are
5 extracted from the noise composite waveform, and
6 overdelay/racing checking for the noticed wiring
7 line is performed using the maximum delay time and
8 the minimum delay time.

1 4. The noise checking method as set forth in
2 claim 1, characterized in that, where the signal
3 waveform which propagates in the noticed wiring
4 line is a clock waveform, when the noise checking
5 is performed, a pulse period of the noise composite
6 waveform is calculated from crossing points of the
7 noise composite waveform and a high level

8 discrimination threshold value/low level
9 discrimination threshold value for the signal
10 waveform, and pulse period checking of the clock
11 waveform in the noticed wiring line is performed
12 based on the pulse period.

1 5. The noise checking method as set forth in
2 claim 1, characterized in that, where the signal
3 waveform which propagates in the noticed wiring
4 line is a clock waveform, when the noise checking
5 is performed, a rising width and a falling width
6 of the noise composite waveform are calculated from
7 crossing points of the noise composite waveform and
8 a high level discrimination threshold value/low
9 level discrimination threshold value for the signal
10 waveform, and pulse width checking of the clock
11 waveform in the noticed wiring line is performed
12 based on the rising width and the falling width.

1 6. The noise checking method as set forth in
2 claim 1, characterized in that, where the signal
3 waveform which propagates in the noticed wiring
4 line is a clock waveform, when the noise checking
5 is performed, a time required for the noise
6 composite waveform to rise and another time
7 required for the noise composite waveform to fall
8 are calculated from crossing points of the noise

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9 composite waveform and a high level discrimination
10 threshold value/low level discrimination threshold
11 value for the signal waveform, and checking of the
12 rising time/falling time of the clock waveform in
13 the noticed wiring line is performed based on the
14 times.

1 7. The noise checking method as set forth in
2 claim 1, characterized in that, when the simulation
3 is performed, the simulation model is divided into
4 a plurality of files, and simulations with regard
5 to the plurality of files are executed individually
6 by a plurality of processing sections of a parallel
7 processor which operate parallelly, whereafter
8 simulation result files by said plurality of
9 processing sections are combined.

1 8. The noise checking method as set forth in
2 claim 1, characterized in that, when the simulation
3 is performed, the simulation model is divided into
4 a plurality of files, and simulations with regard
5 to the plurality of files are executed individually
6 by a plurality of processing sections
7 interconnected over a network, whereafter
8 simulation result files by said plurality of
9 processing sections are combined.

1 9. The noise checking method as set forth in
2 claim 1, characterized in that it further comprises
3 the steps of:

4 performing a noise analysis with regard to the
5 noise composite waveform;

6 displaying, if a questionable wiring line
7 which has a bad influence on the noticed wiring line
8 is found by the noise analysis, a wiring line pattern
9 including the noticed wiring line and the
10 questionable wiring line on a display section;

11 calculating, if the questionable wiring line
12 displayed on said display section is moved on said
13 display section by means of a pointing device, an
14 actual movement amount of the questionable wiring
15 line corresponding to an amount of the movement by
16 said pointing device;

17 performing, in the state wherein the
18 questionable wiring line is moved by the actual
19 movement amount, the production of the simulation
20 model, the simulation, the synthesis of the noise
21 composite waveform and the noise checking again;
22 and

23 displaying the noise composite waveform after
24 the movement of the questionable wiring line on said
25 display section.

1 10. The noise checking method as set forth in

2 claim 1, characterized in that it further comprises
3 the steps of:

4 performing a noise analysis with regard to the
5 noise composite waveform;

6 displaying, if a noise waveform which has a
7 bad influence on the noticed wiring line is found
8 by the noise analysis, the noise waveform on a
9 display section; and

10 calculating, if the noise waveform displayed
11 on said display section is moved on said display
12 section by means of a pointing device, a timing
13 changing amount of the noise waveform corresponding
14 to an amount of the movement by said pointing device
15 and dynamically changing a generation timing of the
16 noise waveform by the timing changing amount.

1 11. The noise checking method as set forth in
2 claim 10, characterized in that the synthesis of
3 the noise composite waveform and the noise checking
4 are performed again using the noise waveform whose
5 generation timing has been dynamically changed, and
6 the noise composite waveform after the timing
7 changing of the noise waveform is displayed on said
8 display section.

1 12. The noise checking method as set forth in
2 claim 1, characterized in that it further comprises

calculating, where ringing is superposed on the noise composite waveform, a damping resistance value with which the ringing can be eliminated if the damping resistor is added to the noticed wiring line;

12 performing, in a state wherein a part selected
13 from among the candidate part data is added to the
14 noticed wiring line, the production of the
15 simulation model, the simulation, the synthesis of
16 the noise composite waveform and the noise checking
17 again; and

1 13. The noise checking method as set forth in
2 claim 1, characterized in that,

time axis direction distributions of a maximum value and a minimum value of the signal waveform with a delay variation taken into consideration are calculated and time axis direction distributions of a maximum value and a minimum value of a noise

10 waveform with a noise generation timing variation
11 taken into consideration are calculated for each
12 kind of noise, and

13 time axis direction distributions of the
14 maximum value and the minimum value obtained by
15 synthesizing the time axis direction distributions

16 of the maximum value and the minimum value of the
17 signal waveform and the time axis direction
18 distributions of the maximum value and the minimum
19 value of the noise waveforms are used as the noise
20 composite waveform.

1 14. The noise checking method as set forth in
2 claim 13, characterized in that, when the noise
3 checking is performed, it is discriminated whether
4 or not both of the time axis direction distributions
5 of the maximum value and the minimum value of the
6 noise composite waveform satisfy logical expected
7 values for a check object pin.

1 15. The noise checking method as set forth in
2 claim 13, characterized in that,

3 when the simulation is performed, a single
4 signal waveform is calculated under a predetermined
5 condition and a single noise waveform for each kind
6 of noise is calculated under the predetermined
7 condition, and,

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1 17. The noise checking method as set forth in

1 18. The noise checking method as set forth in
2 claim 13, characterized in that, when a racing check
3 of the signal waveform is performed by the noise
4 checking, upon rising of the signal waveform, a
5 waveform obtained by synthesizing the time axis
6 distribution of the maximum value of the noise
7 waveform with the signal waveform is used as the
8 noise composite waveform, but upon falling of the
9 signal waveform, another waveform obtained by
10 synthesizing the time axis distribution of the
11 minimum value of the noise waveform with the signal
12 waveform is used as the noise composite waveform.

1 19. A noise checking apparatus used upon
2 circuit designing for checking noise which has an

a noise checking section (6) for performing noise checking based on the noise composite waveform obtained by said noise waveform synthesis section (5).

20. The noise checking apparatus as set forth in claim 19, characterized in that, where an

21. The noise checking apparatus as set forth in claim 19, characterized in that said noise checking section (6) extracts a maximum delay time and a minimum delay time of the noticed wiring line from the noise composite waveform and performs overdelay/racing checking for the noticed wiring line using the maximum delay time and the minimum delay time.

1 22. The noise checking apparatus as set forth
2 in claim 19, characterized in that, where the signal
3 waveform which propagates in the noticed wiring

4 line is a clock waveform, said noise checking
5 section (6) calculates a pulse period of the noise
6 composite waveform from crossing points of the
7 noise composite waveform and a high level
8 discrimination threshold value/low level
9 discrimination threshold value for the signal
10 waveform and performs pulse period checking of the
11 clock waveform in the noticed wiring line based on
12 the pulse period.

1 23. The noise checking apparatus as set forth
2 in claim 19, characterized in that, where the signal
3 waveform which propagates in the noticed wiring
4 line is a clock waveform, said noise checking
5 section (6) calculates a rising width and a falling
6 width of the noise composite waveform from crossing
7 points of the noise composite waveform and a high
8 level discrimination threshold value/low level
9 discrimination threshold value for the signal
10 waveform and performs pulse width checking of the
11 clock waveform in the noticed wiring line based on
12 the rising width and the falling width.

1 24. The noise checking apparatus as set forth
2 in claim 19, characterized in that, where the signal
3 waveform which propagates in the noticed wiring
4 line is a clock waveform, said noise checking

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5 section (6) calculates a time required for the noise
6 composite waveform to rise and another time
7 required for the noise composite waveform to fall
8 from crossing points of the noise composite
9 waveform and a high level discrimination threshold
10 value/low level discrimination threshold value for
11 the signal waveform and performs checking of the
12 rising time/falling time of the clock waveform in
13 the noticed wiring line based on the times.

1 25. The noise checking apparatus as set forth
2 in claim 19, characterized in that said simulation
3 section (4) includes:

4 a file dividing section for dividing the
5 simulation model into a plurality of files;

6 a parallel processor having a plurality of
7 processing sections for executing simulations with
8 regard to the plurality of files obtained by the
9 division of said file dividing section parallelly;
10 and

11 a file combining section for combining
12 simulation result files by said plurality of
13 processing sections.

1 26. The noise checking apparatus as set forth
2 in claim 19, characterized in that said simulation
3 section (4) includes:

~~a network interconnecting a plurality of processing sections for executing simulations with regard to the plurality of files parallelly; and~~

27. The noise checking apparatus as set forth in claim 19, characterized in that it further comprises:

a display section for displaying, if a questionable wiring line which has a bad influence on the noticed wiring line is found by said noise composite waveform analysis section, a wiring line pattern including the noticed wiring line and the questionable wiring line;

a movement amount calculation section for calculating an actual movement amount of the questionable wiring line corresponding to an amount

1 28. The noise checking apparatus as set forth
2 in claim 19, characterized in that it further
3 comprises:
4 a noise composite waveform analysis section
5 for performing a noise analysis with regard to the
6 noise composite waveform;
7 a display section for displaying, if a noise
8 waveform which has a bad influence on the noticed
9 wiring line is found by said noise composite
10 waveform analysis section, the noise waveform; and
11 a timing changing amount calculation section
12 for calculating a timing changing amount of the
13 noise waveform corresponding to an amount of the
14 movement by said pointing device and dynamically
15 changing a generation timing of the noise waveform
16 by the timing changing amount.

1 29. The noise checking apparatus as set forth
2 in claim 28, characterized in that said noise
3 waveform synthesis section (5) and said noise
4 checking section (6) are operated again in a state
5 wherein the generation timing of the noise waveform
6 is changed, and the noise composite waveform after
7 the timing changing of the noise waveform is
8 displayed on said display section.

1 30. The noise checking apparatus as set forth
2 in claim 19, characterized in that it further
3 comprises:

4 a damping resistance value calculation
5 section for calculating, where ringing is
6 superposed on the noise composite waveform, a
7 damping resistance value with which the ringing can
8 be eliminated if the damping resistor is added to
9 the noticed wiring line;

10 a part searching section for searching for
11 candidate part data corresponding to the damping
12 resistance value calculated by said damping
13 resistance value calculation section;

14 a displaying section for displaying the
15 candidate part data searched out by said part
16 searching section; and

17 a selective inputting section for selecting
18 a part from among the candidate part data displayed

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19 on said display section; and that,
20 in a state wherein the part selected from among
21 the candidate part data is added to the noticed
22 wiring line, said model production section (3),
23 said simulation section (4), said noise waveform
24 ~~synthesis section (5) and said noise checking~~
25 ~~section (6)~~ are operated again, and the noise
26 composite waveform after the addition of the part
27 is displayed on said display section.

1 31. The noise checking apparatus as set forth
2 in claim 19, characterized in that said noise
3 waveform synthesis section (5)

calculates time axis direction distributions of a maximum value and a minimum value of the signal waveform with a delay variation taken into consideration and calculates time axis direction distributions of a maximum value and a minimum value of a noise waveform with a noise generation timing variation taken into consideration for each kind of noise, and

12 synthesizes the time axis direction
13 distributions of the maximum value and the minimum
14 value of the signal waveform and the time axis
15 direction distributions of the maximum value and
16 the minimum value of the noise waveforms to obtain
17 time axis direction distributions of the maximum

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8 said noise waveform synthesis section (5)
9 shifts the calculated single signal waveform within
10 a range of the delay variation to calculate time
11 axis direction distributions of the maximum value
12 and the minimum value of the signal waveform and
13 shifts the calculated single noise waveform for
14 each kind of noise within a range of the noise
15 generation timing variation to calculate, for each
16 kind of noise, time axis direction distributions

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17 of the maximum value and the minimum value of the
18 noise waveform.

1 34. The noise checking apparatus as set forth
2 in claim 31, characterized in that, where the noise
3 waveform exists across a plurality of clock cycles,
4 said noise waveform synthesis section (5) extracts
5 maximum values and minimum values of the noise
6 waveform in the same phase of each clock cycle from
7 the clock cycles respectively to produce a maximum
8 value compressed noise waveform and a minimum value
9 compressed noise waveform wherein the maximum
10 values and the minimum values of the noise waveform
11 are compressed into one clock cycle respectively,
12 and uses the compressed noise waveforms as the time
13 axis direction distributions of the maximum value
14 and the minimum value of the noise waveform,
15 respectively.

1 35. The noise checking apparatus as set forth
2 in claim 31, characterized in that, when said noise
3 checking section (6) performs an overdelay check
4 of the signal waveform, said noise waveform
5 synthesis section (5) synthesizes, upon rising of
6 the signal waveform, the time axis distribution of
7 the minimum value of the noise waveform with the
8 signal waveform to obtain the noise composite

9 waveform, but synthesizes, upon falling of the
10 signal waveform, the time axis distribution of the
11 maximum value of the noise waveform with the signal
12 waveform to obtain the noise composite waveform.

1 36. The noise checking apparatus as set forth
2 in claim 31, characterized in that, when said noise
3 checking section (6) performs a racing check of the
4 signal waveform, said noise waveform synthesis
5 section (5) synthesizes, upon rising of the signal
6 waveform, the time axis distribution of the maximum
7 value of the noise waveform with the signal waveform
8 to obtain the noise composite waveform, but
9 synthesizes, upon falling of the signal waveform,
10 the time axis distribution of the minimum value of
11 the noise waveform with the signal waveform to
12 obtain the noise composite waveform.

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